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**harper
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consultants in water &
waste management

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uter building
marion street
e, washington
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206) 622-0812

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**DUWAMISH GROUND WATER STUDIES
WASTE DISPOSAL PRACTICES AND
DREDGE AND FILL HISTORY**

Prepared for:

Sweet Edwards and Associates

Prepared by:

Harper-Owes

DRAFT

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DUWAMISH GROUND WATER STUDIES
WASTE DISPOSAL PRACTICES
AND DREDGE AND FILL HISTORY

SCOPE OF WORK

This report presents a review of historical waste disposal and dredge/fill practices in the Duwamish River area. The emphasis of the review has been placed on identifying potential sources of contamination to the Duwamish area ground water. The scope of work for this review does not include information on direct waste discharges into the Duwamish River, but concentrates on waste disposal and dredge/fill practices which may affect ground water quality.

WASTE DISPOSAL PRACTICES

Information Sources

Information for the review of waste disposal practices has been obtained from the following sources:

1. Aerial Photography Analysis of Hazardous Waste Sites, Duwamish Valley, Washington. United States Environmental Protection Agency, Las Vegas, 1982.
2. An Investigation of Pollution in the Green-Duwamish River. Pollution Control Commission, Technical Bulletin 20, 1955.
3. Municipality of Metropolitan Seattle Industrial Waste Section files.
4. Washington State Department of Ecology NPDES and Hazardous Waste Files (includes Pollution Control Commission Reports).
5. Remedial Action Master Plan, Harbor Island, USEPA Hazardous Site Control Division.
6. USEPA Hazardous Waste Files

7. Photographic Analysis of Reichold Waste Site, Seattle, USEPA, Las Vegas, 1981.
8. Water Quality Assessment of the Duwamish Estuary, Washington. Harper-Owes for Municipality of Metropolitan Seattle. Seattle, 1983.

Waste Disposal Practices

Identified waste disposal sites and unidentified potential sites are listed by location proceeding from the north to the south. Dates listed refer to the year when the site was documented. Reference numbers refer to the information sources listed above. Site locations can be found in Figures 1 through 3.

1. ~~Wycoff~~; Reference Nos. 3, 4

~~Wycoff~~ generates and stores the following sludges on site: pentachlorophenol sludge, copper arsenate sludge and creosote sludge. Oily seepage into the intertidal area surrounding the plant is evident. Detailed information from USEPA files on Wycoff is presently not available because of pending litigation and enforcement action.

2. (1961) N47 35.2' - W122 21'; Reference No. 1

This site was used as a liquid disposal area. Aerial photography showed a pool of dark-toned liquid in the middle of the site. By 1968, this site was developed into a transshipment point and the site covered by railroad facilities.

3. (1940) N47 34.9' - W122 19.75'; Reference No. 1

This was a general dump site which did not appear to be associated with any local industry. Aerial photography from 1961 shows that the site was covered over by industrial development.

4. Quemetco (Sea Fab Metals) (1975); Reference Nos. 3, 4, 5

A seepage pond was used by Quemetco for disposal of their process wastewater including spent chemicals, battery acid solution and most of yard

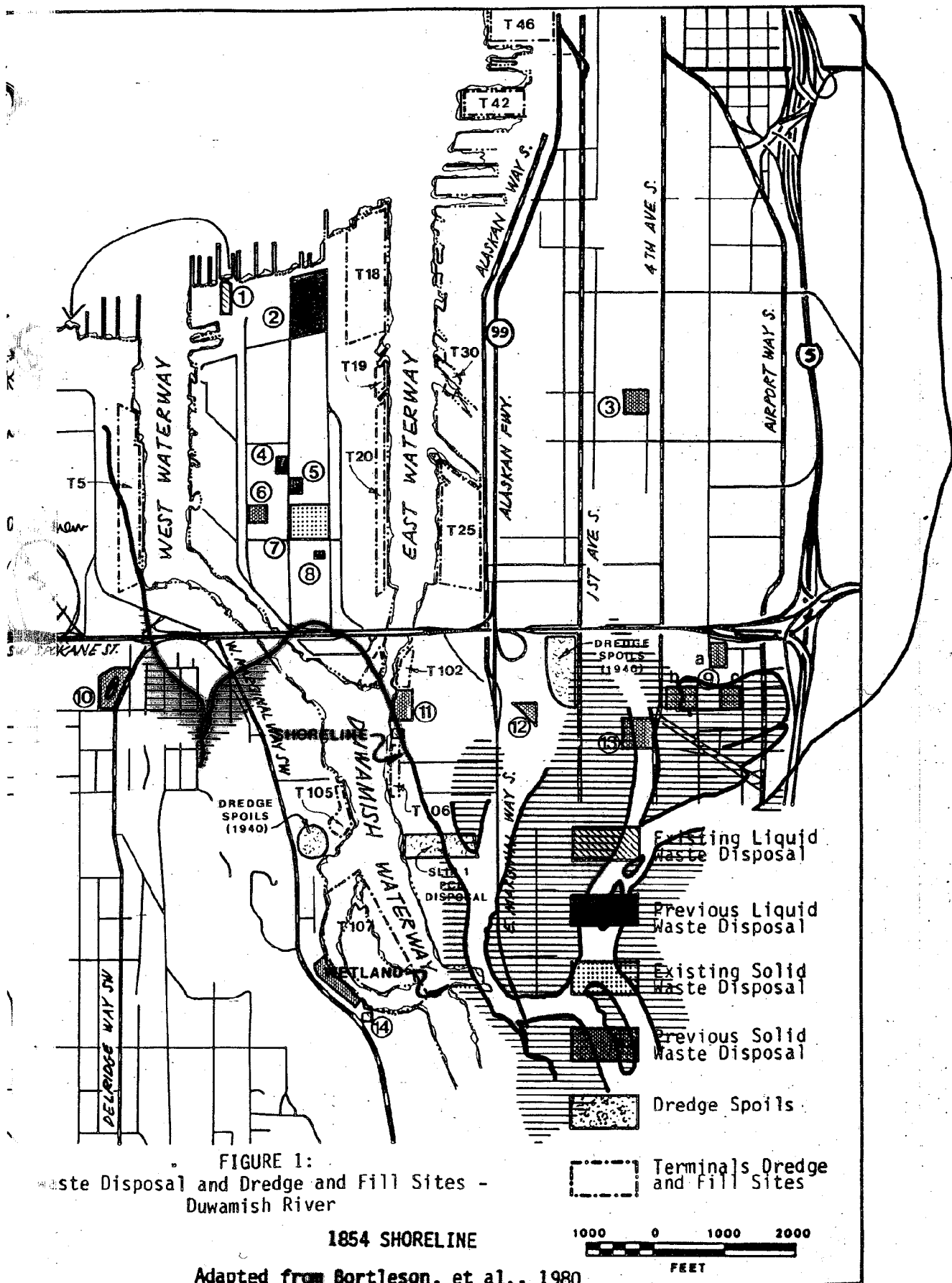
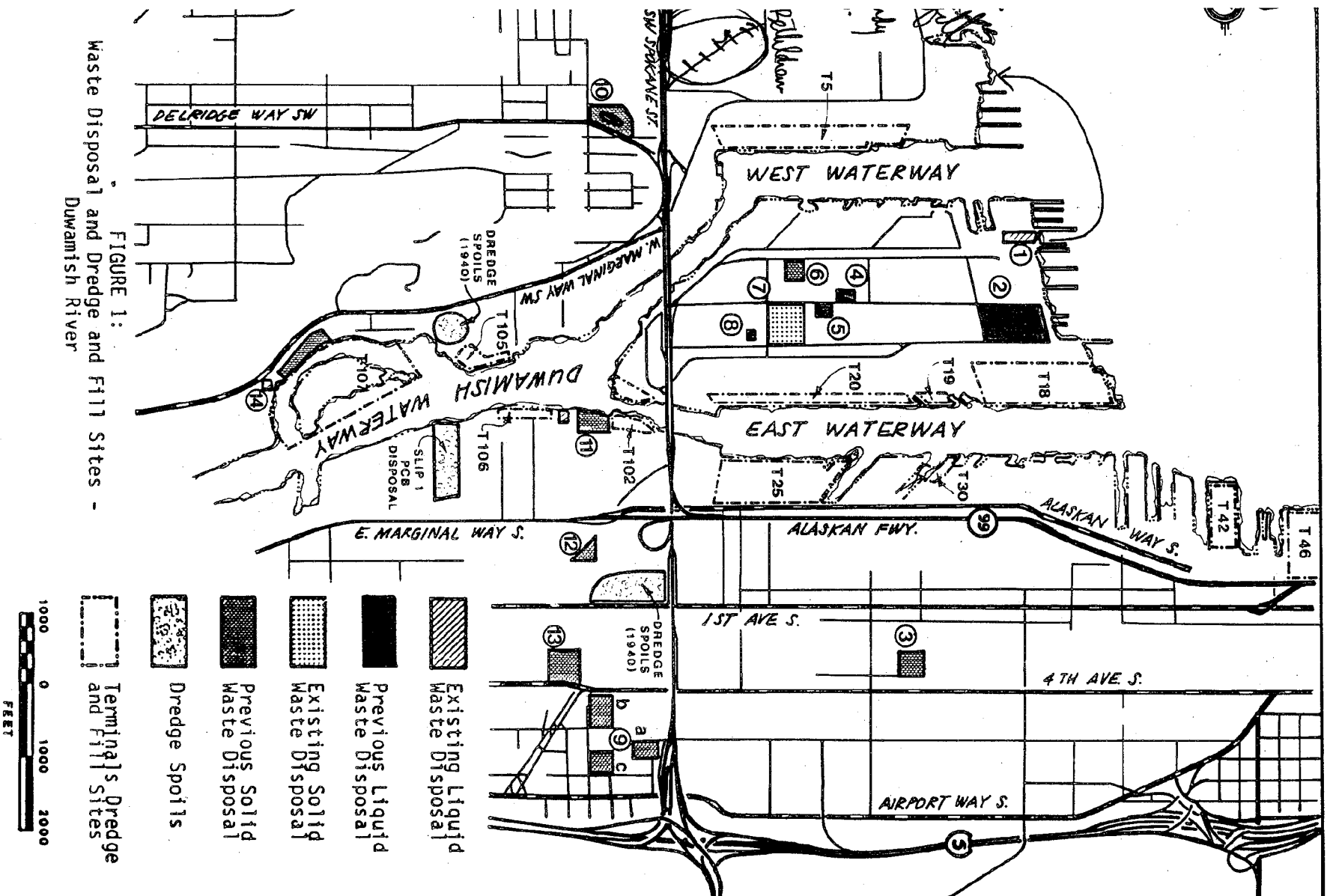
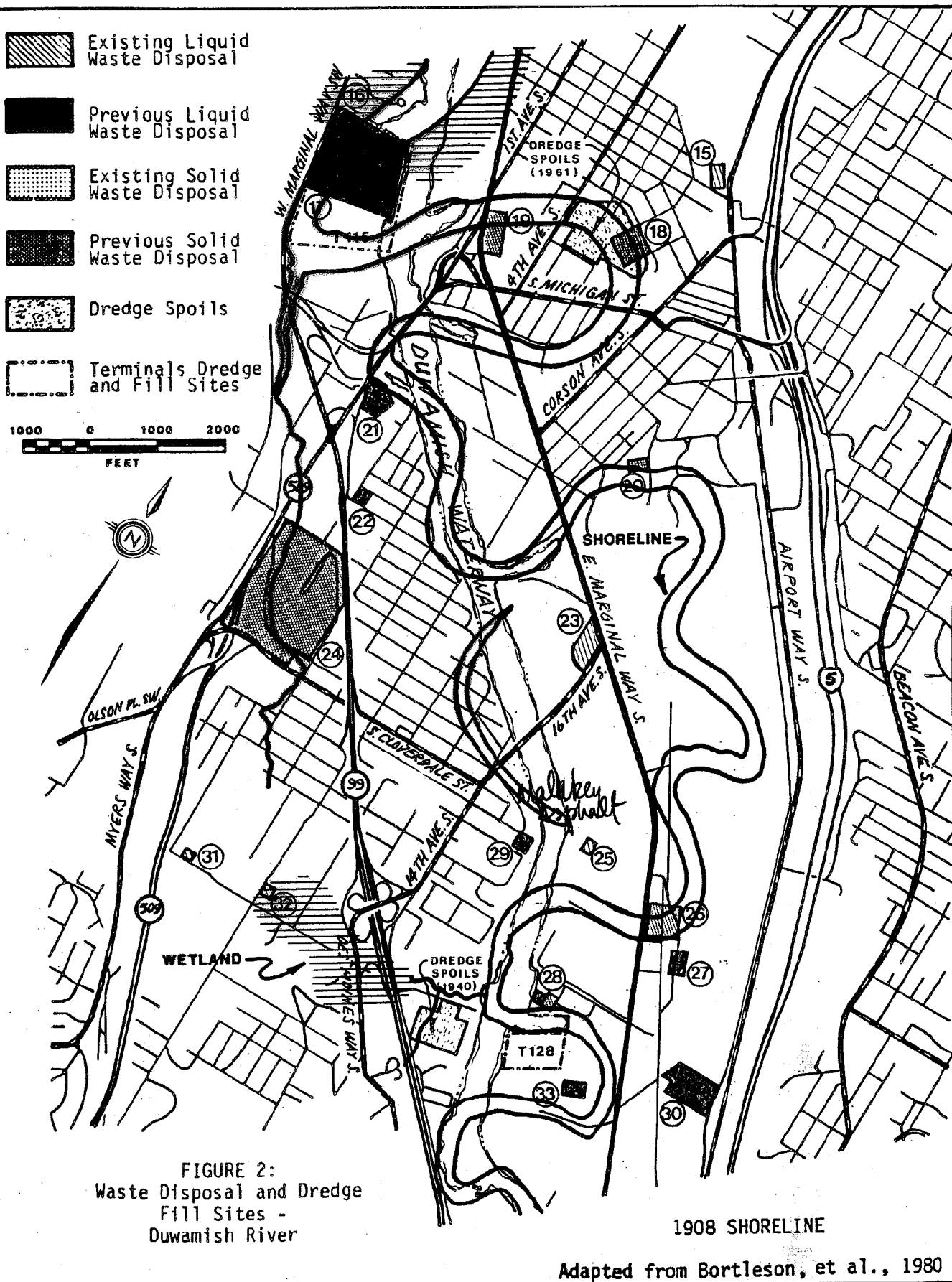


FIGURE 1:
Waste Disposal and Dredge and Fill Sites -
Duwamish River





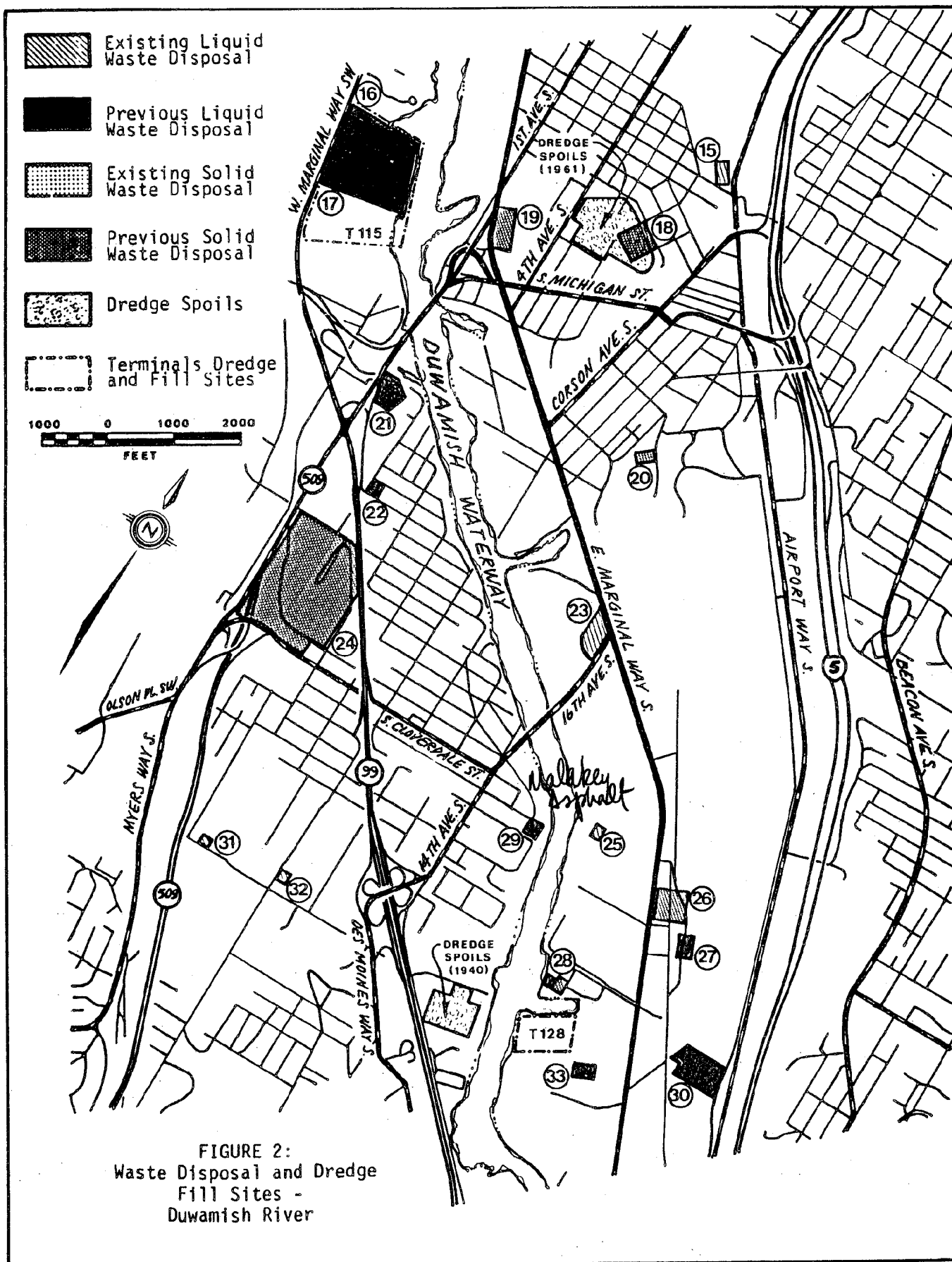


FIGURE 2:
Waste Disposal and Dredge
Fill Sites -
Duwamish River

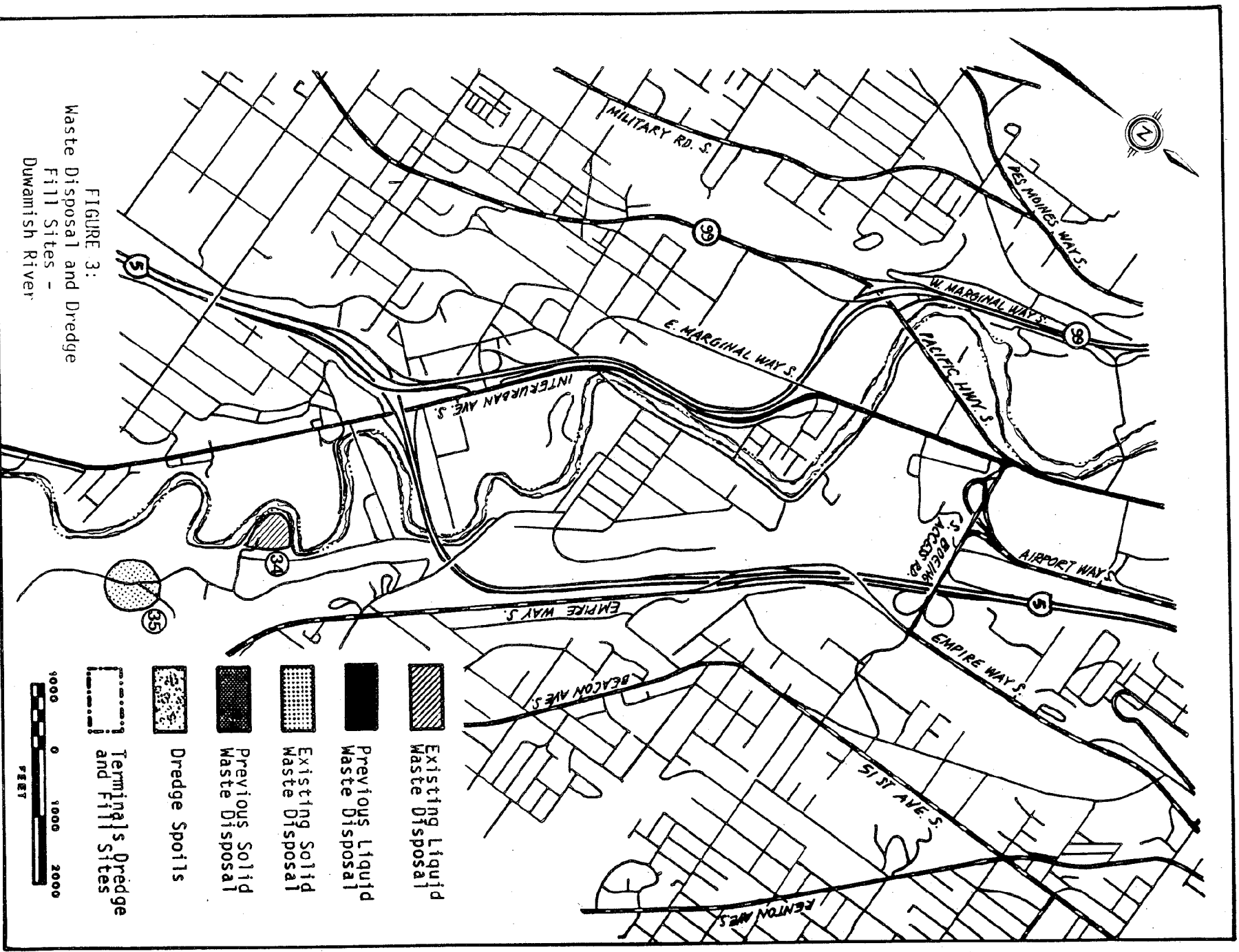


FIGURE 3:
Waste Disposal and Dredge
Fill Sites -
Duwamish River

drainage from 1975 until January 1982. The seepage pond was part of a treatment system consisting of ammonia neutralization, vacuum filtration and final disposal in the seepage pond.

Characterization of Quemetco's process waste water is given in Table 1. Water samples were collected from the seepage pond where wastewater had received prior neutralization and vacuum filtration. In 1970, it was reported that 25 gpm of wastewater was discharged. It was also reported that sludge was removed twice per year.

Prior to 1975, wastewater was discharged directly to an impoundment without pretreatment. 1974 aerial photography indicates that this impoundment was in the same location as the seepage pit. The pond was located just off 13th Avenue Southwest.

In 1983, the lagoon was bypassed and a monitoring well was installed on Quemetco's property as part of the RCRA-enforced cleanup of the seepage lagoon. Quemetco also has open storage of old batteries on site and two types of waste piles. The waste piles contain Diatomaceous earth and rubber chips. The lagoon and waste piles have been classified as a hazardous waste site under the Superfund Program and the company (Sea Fab) has recently submitted a plan for closure of the facility to the Department of Ecology. This plan be obtained from DOE.

Check to see if stuff has already been removed.

5. **Golden Penn Oil Company, 2937-13th Avenue Southwest; Reference No. 4**

Golden Penn Oil Company was a waste solvent recycler. There is a possibility that a sludge lagoon was located at this site and that hazardous wastes were handled along with the waste solvents.

TABLE 1. Quemetco Process Wastewater Quality Data

		Contaminant Concentration (mg/l)												Comments
Date	Sample Time Period	Cadmium		Chromium		Copper		Nickel		Lead		Zinc		
		Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	
10/6/76	0000 to 2245	0.15	0.58	0.01	0.02	0.94	13.0	0.45	0.79	1.0	4.1	1.0	1.9	Discharge to leach pit
11/10/77	0000 to 1630	0.30	--	0.06	--	1.2	1.5	0.48	--	3.6	5.6	1.3	1.9	Discharge to leach pit
11/11/77	0330 to 0830	NS	NS	NS	NS	1.3	1.4	NS	NS	5.7	7.0	1.2	1.3	Discharge to leach pit
2/21/78	1430	NS	NS	NS	NS	0.18	--	NS	NS	3.6	--	0.26	--	Discharge to leach pit
6/13/79	1120 to 1620	NS	NS	NS	NS	1.0	2.2	NS	NS	0.15	0.30	0.33	0.93	Discharge to leach pit
6/14/79	0020 to 0920	0.95	--	0.04	--	3.8	8.4	0.49	--	3.1	4.9	3.4	6.9	Discharge to leach pit
7/12/79	0000 to 2000	1.0	--	0.02	--	1.6	--	0.59	0.73	0.75	1.3	0.57	--	Discharge to leach pit
7/13/79	0300 to 0900	NS	NS	NS	NS	NS	NS	1.2	1.7	0.64	1.8	NS	NS	Discharge to leach pit
10/28/80	0000 to 2245	1.0	1.5	0.09	--	3.4	4.9	0.16	--	3.3	5.9	3.5	5.5	Discharge to leach pit
6/2/81	1530 to 2230	0.96	1.1	<0.04	<0.04	2.3	3.2	0.56	0.64	2.3	4.1	0.81	0.98	Discharge to leach pit
6/3/81	0930	<0.01	--	<0.04	--	<0.02	--	0.02	--	0.04	--	<0.01	--	Discharge to leach pit
7/22/81	1600	0.07	--	0.02	--	1.0	--	0.39	--	0.88	--	1.3	--	Discharge to leach pit
10/22/81	0000	2.1	--	0.06	--	4.0	--	1.1	--	4.4	--	0.79	--	Discharge to leach pit
11/24/81	1015 to 2215	1.7	2.0	<0.02	<0.02	2.8	7.6	1.1	1.3	3.4	7.1	3.0	5.8	Discharge to leach pit
11/25/81	0121 to 0921	1.0	1.2	<0.02	<0.02	4.7	7.4	0.55	0.61	2.7	4.6	1.0	1.1	Discharge to leach pit

TABLE 1. Quemetco Process Wastewater Quality Data
(continued)

		Contaminant Concentration (mg/l)												Comments
Date	Sample Time Period	Cadmium		Chromium		Copper		Nickel		Lead		Zinc		
		Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	
12/31/81	0000	-- Samples Not Analyzed --												
2/10/82	1140	2.2	--	0.02	--	7.1	--	0.63	--	0.49	--	0.55	--	Discharge to leach pit
5/26/82	1221 to 1921	0.9	1.1	0.02	0.02	1.6	3.4	0.5	0.6	6.8	15.0	1.6	2.1	Discharge to sanitary sewer
9/7/82	1000 to 2200	3.1	8.1	0.03	0.04	5.4	13.0	1.4	3.2	0.69	1.5	1.3	5.9	Discharge to sanitary sewer
9/8/82	0200 to 0900	0.13	0.17	<0.02	<0.02	<0.24	0.32	0.10	0.12	0.11	0.14	0.07	0.08	Discharge to sanitary sewer

Source: Letter from Denise Healy, Industrial Waste Investigator, Water Quality Division, Municipality of Metropolitan Seattle to Joan McNamee, Toxic Substance Control Branch, U.S. EPA, Region X, dated August 10, 1983.

Notes: NS = Not Sampled.

Available data have been numerically averaged and summarized. Only the average and peak concentrations are shown for the contaminants measured. Samples were generally collected at regular intervals throughout the sampling period, making weighted averages unnecessary.

6. (1940) N47 34.6' - W122 21.2'; Reference No. 1

This was a small industrial facility with waste dumping located on a wetlands area. Piles of white material were located on the site. Aerial photography from 1961 shows that the area has been developed and the dumping location covered over.

7. Seattle Iron and Metal, 2955-11th Avenue Southwest, Harbor Island; Reference Nos. 3, 4

Wastewater at Seattle Iron and Metal is produced from the copper wire wash area. Wire which has been burned to remove the insulation is washed in a non-enclosure area and the water drains into a pit used for settling. The pit also accepts stormwater and overflows into the storm drain system. The results of a washwater sample tested in 1974 can be found in Table 2.

TABLE 2. Washwater Sample From Seattle Iron and Metal

Parameter	Concentration (mg/l)
Copper	0.760
Lead	0.800
Zinc	0.440
Nickel	0.140

run off into
center of yard
then Metro
sample
→

The site also contains an unpaved scrap iron storage area where rainwater collects and seeps into the ground. The site is lower than the surrounding streets and runoff drains into the facility.

8. Value Plating and Metal Polishing, 3207-11th Avenue Southwest; Reference No. 3

Value opened in 1970 and discharged wastewater onto the ground behind their shop until they were connected to the sewer in 1978. Metals concentrations of their waste discharged to Metro's sewers are listed in Table 3.

TABLE 3. Wastewater Sample From Value Plating and Metal Polishing

Parameter	Concentration (mg/l)
Cadmium	0.23
Chromium	95
Copper	55
Nickel	209
Lead	0.42
Zinc	6.3

Value also stores chemical drums on unpaved ground behind their shops. Acid drippings from their processes fall onto unpaved ground and flow into a poorly maintained concrete sump.

9.a,b,c. (1940) N47 34.15' - W122 19.6'; Reference No. 1

These sites all appeared to be small general refuse dumps. By 1968, sites A and B were covered by commercial development. Site 4(C) is still in service as an auto wrecking site.

10. Bethlehem Steel Company, 8501 E. Marginal Way (1955);
Reference Nos. 2, 3, 4, 6

Bethlehem Steel Company fabricates and galvanizes steel. Sulphuric acid pickling liquor wastes were disposed of on land at the slag dump as early as 1955. Wastewater deposited on site included electroplate, hot dip and coil pickle processes.

Treatment of contact cooling water consisted of primary settling in scale settling pits, gravity oil separation and final holding in a pond for reuse at the plant. Solids were removed from the settling basin on a regular basis and deposited at the slag dump located on Southwest Andover, between 28th Southwest and 26th Southwest.

The slag dump was operated for about 20 years and contains about a four foot depth of waste material. The facility was also operated as a waste storage pile for flame trap sludge in the 1970's.

The facility closed in 1983 and Bethlehem Steel has submitted a closure plan to the EPA which recommends the removal of the contaminated slag and soils at the disposal site. Bethlehem Steel and Applied Geotechnology, Inc. are also due to soon release a Ground Water Monitoring Summary Report on the effects of the disposal site on the upper aquifer.

Early ground water monitoring results from 1982 are presented in Table 4. The EPA reports that these results must be evaluated with care because tidal effects in the area distort typical down gradient contaminant migration patterns.

11. **Ash Grove Cement (Lone Star), 3801 E. Marginal Way South; Reference No. 3**

All storm and wastewater generated at the Ash Grove site is diverted to an unlined surge pond. *close to the east bank of the Duwamish Waterway* There is no surface discharge from this pond as the water is reused in their processes. Result of a water sample analysis from the pond is listed in Table 5.

TABLE 4. Ground Water Monitoring Results from Bethlehem Steel Site

Parameter	Up Gradient test well	Down Gradient test well
Cadmium (mg/l)	0.016	0.024
Chromium (mg/l)	0.20	0.05
Lead (mg/l)	0.52	0.51

TABLE 5. Ash Grove Cement Surge Pond Water Analysis

Parameter	Concentration
pH	10.8
Copper (mg/l)	0.1
Zinc (mg/l)	0.13
Iron (mg/l)	2.3
Chromium (mg/l)	0.35
Lead (mg/l)	0.56
Conductivity (umhos)	225
Hardness (mg/l)	120

A variety of materials is stored on-site at Ash Grove Cement on unpaved areas. Ash Grove buys 25,000 tons of Asarco slag per year, which is stock-piled outside, uncovered. Coal fly ash is also stored outside, uncovered. Coal is stored outside in coal pits which are partially covered with black plastic tarps. Oil diesel and lubricants are stored in drums and tanks on a concrete platform surrounded by an unpaved area where spillage can seep into the ground. Ash Grove has also deposited brick, concrete, waste cement and dust in a landfill adjacent to the river.

12. (1961) N47 34.1' - W122 20.15'; Reference No. 1

This site is located adjacent to the Puget Sound Fabricators facility and contains several piles of white-toned waste material.

13.A. Seattle City Light Substation (1961) N47 34.05' - W122 20.15'; Reference Nos. 1, 3

This site was used as a dump area for trash and other waste material and is located just south of the Duwamish substation. By 1968, this site was covered by commercial development.

This material was removed from the site in 1985. Runoff from this area This area was removed in 1985 and. Oil and lubricant storage is now in a covered building

The Duwamish substation drainage systems contain gravel oil retention sumps which collect transformer area runoff before being pumped directly to the Duwamish. The two transformers at this station are not PCB transformers.

Drainage from the capacitor banks at the substation drains directly onto the soil. All of the capacitors in these banks are PCB equipment.

13.B. Seattle City Light Georgetown Steamplant; Reference No. 3

The Georgetown steamplant was last operated in November 1974. SCL representatives state that no PCB equipment has ever been used at this site.

The storm water pond located at the southwest corner of City Light's property was found to contain 500 mg/kg PCB in a composite sediment sample. The pond receives flows from Seattle City Light property and from the ^{King County} Boeing ^(Boeing Field) Airport. PCB's have also been found in the North Fire pits of Boeing field, which drain into the pond, but at much lower concentrations. Seattle City Light is conducting an investigation of the PCB sources which is scheduled for completion in February 1985.

A small dumpsite was also located just north of the pond and may have received waste oils. The dump site was closed and cleaned up in 1983 and does not appear to be a PCB source.

14. Ideal Cement Company, 5400 W. Marginal Way Southwest; Reference No. 4

Kiln and truck washdown water are disposed of in a soaking pit/settling pond. There is also a flue dust fill site located on West Marginal Way South and South Hudson.

15. Chempro (1980) N47 33.25' - W122 19.3'; Reference No. 1

Chempro recycles waste solvents. Analysis of 1980 color photography reveals that this site contained numerous 55 gallon drums, most of which were

Check with Larry

stored on a concrete pad at the north end of the site. Solvents are also stored in several underground tanks. A ground water monitoring study of the Chempro site was conducted by Harper-Owes in 1984 for Chempro and has not been released by the industry. *Isn't it available now?*

16. **MRI (MST Chemicals), 6000 West Marginal Way Southwest;
Reference Nos. 3, 4**

MRI was constructed in 1963 and processes tin plate scrap. The company operated two evaporation/seepage lagoons for disposal of its wastewater until 1976 when they connected to the Metro sewer system. The lagoons were unlined basins of six foot depth into which about 3500 gallons per week were discharged. In 1969, the waste was reported as containing a pH of 11; 25,000 mg/l NaOH; 50,000 mg/l alkalinity; and 200 to 500 mg/l Na_2SnO_3 . The waste also contained high COD and BOD.

Sludge from the lagoon is reported to have been removed periodically. The present quality of wastewater inputs to Metro's sewer from MRI can be found in Table 6.

TABLE 6. 1981 MRI Wastewater Quality Analysis

Parameter	Concentration (mg/l)
Aluminum	83
Antimony	4.1
Arsenic	0.26
Zinc	3.0
Thallium	0.87
Nickel	1.3
Lead	3.6
Iron	110
Cadmium	0.20

17. **Reichold Chemical Company, 5900 West Marginal Way;
Reference Nos. 1, 2, 7**

The Reichold plant manufactured synthetic resins, formaldehyde, pentachlorophenols and hydrochloric acid. Highly toxic wastewater was discharged directly into the river until the summer of 1955 when corrective action was taken by the industry in the form of temporary settling basins for the wastewater. EPA files indicate that the plant was closed in 1958.

Aerial photography taken in 1960, 1961 and 1970 show three wastewater disposal pits contained by earthen dikes at the Reichold site. The site occupied approximately 15 acres. By 1970, a major dike had been constructed to separate the area from the river and the process of filling behind the dike had commenced. By 1974 the entire site was filled and paved over and now serves as a transshipment area.

18. **(1940) N47 32.95' - W122 19.45'; Reference No. 1**

This site was a possible waste pit containing white-toned material. By 1961, the site was covered by fill material and by 1968, commercially and industrially developed.

19. **(1940) N47 32.8' - W122 19.9'; Reference No. 1**

This site consisted of two small dump areas. The site was covered by industrial development in 1961.

20. **(1940) N47 32.5' - W122 19.0'; Reference No. 1**

This site was a small dump probably associated with a nearby industry. By 1961, the site was covered by commercial development associated with King County International Airport.

21. **Northwest Cooperage Company, 7152 First Avenue South (1961); Reference Nos. 1, 2**

Northwest Cooperage Company reconditions and repaints old barrels and drums. Aerial photography from 1961, 1968 and 1974 shows several thousand drums stored throughout the site. 1980 color photography reveals ground stains indicating past spills.

22. **Liquid Air Company, 7560 Second Avenue South; Reference No. 4**

Wastewater from acetylene production was disposed of in ponds up until 1979. The ponds were excavated and filled by 1984.

23. **AirCo (1940), 7700 14th Avenue South; Reference No. 1**

This industry had two pits containing white acetylene waste material. Most of the site had been developed into a parking lot by 1961. At the north end of the site, a two acre triangular pit of 10-15 feet depth still exists and receives carbide residue from acetylene manufacture. Calcium carbonate is also stockpiled on-site.

24. **(1940) N47 31.75' - W122 19.8'; Reference No. 1**

In 1940, these sites were the local garbage dump. Aerial photography indicates a wide variety of waste material.

By 1961, the sites were expanded and developed into a landfill. A portion of the area serves as an auto junkyard. Two liquid waste disposal ponds were located on the site. One contained a light-toned liquid with black material on the surface, the other a dark-toned liquid.

By 1968, some of the area had been covered over and buildings constructed. The disposal ponds were no longer present and new dumping areas were developed within the site.

By 1974, several buildings were developed on the site and covered the old auto junkyard areas. A storage yard also covered part of the site in 1974 and by 1980, all the dump areas had been developed.

25. Jorgensen Steel, 8531 E. Marginal Way South; Reference No. 3

Jorgensen Steel employed an acid house for etching machine parts, which contained three tanks - two filled with 50 percent muriatic acid and the third with rinse water. The tanks drained into a concrete walled pit with a dirt bottom which was filled with limestone rocks. Analysis results of the solutions in each tank and the soils in the limestone pit can be found in Table 7. The pit was closed in March 1984.

Jorgensen Steel also operates a laydown yard for storage of metal scrap. The yard is unpaved and contains piles of uncovered scrap material.

26. (1940) M47 31.5' - W122 17.9'; Reference No. 1

This site was a small industry with a stockpile of white material. The stockpile was reduced by 1961 and the site covered by parking lots by 1968.

27. Kenworth Truck Company, 8801 East Marginal Way (1955); Reference No. 2

Aluminum deoxidizing tank wastewater from Kenworth was disposed of on land approximately 2000 feet from the river. The waste is presently being transported off the site.

28. Monsanto (1961); Reference Nos. 1, 4

Monsanto manufactures vanillin and has also manufactured resins in the past. Monsanto currently disposes of its Vanillin Black Liquor Solids (VBLS) at the Cedar Hills Landfill. VBLS leachate measured at Cedar Hills has high COD (approximately 20,000 mg/l) and high copper concentrations (300 mg/l).

**TABLE 7. Analysis of Jorgensen Steel Etching Tank Solutions
and Pit Core Samples**

	West tank etching solution (mg/l)	Middle tank etching solution (mg/l)	Rinse tank solution (mg/l)	Limestone core pit (mg/kg)
Total cadmium	.54	L/0.02	L/0.02	L/0.02
Total chromium	600.	920.	7.2	150.
Total nickel	840.	1100.	24.	38.
Total zinc	7.6	24.	1.2	36.
Total copper	230.	190.	5.3	42.
Total iron	20,000.	39,000.	430.	14,000.
Total lead	2.5	8.7	L/0.2	L/20.
Total selenium	0.8	L/0.2	L/0.2	L/20.
Total calcium	65.	140.	22.	---
Total magnesium	130.	230.	4.8	---
Total calcium and magnesium calc. as hardness (CaCO3)	710.	1,500.	74.	---
Water soluble calcium	---	---	---	50.
Water soluble magnesium	---	---	---	1.7
Water soluble calcium calc. as CaCO3	---	---	---	130.
EP Toxicity				
Arsenic	1.6	L/0.2	.2	.4
Barium	L/0.5	L/0.5	L/0.5	L/0.5
Cadmium	.53	L/0.02	L/0.02	L/0.02
Chromium	600.	920.	7.2	L/0.1
Lead	2.5	8.7	L/0.2	L/0.2
Mercury	L/0.005	L/0.005	L/0.005	L/0.005
Selenium	.5	L/0.2	L/0.2	L/0.2
Silver	L/0.1	L/0.1	L/0.1	L/0.1

L/indicates 'less than'.

Monsanto operated a landfill from approximately 1945 to 1955 at the present Kenworth Truck site. The landfill site is now covered by a parking lot and is well drained. Company representatives claim that only reactor vessel scale was deposited in the landfill and that the scale contained only calcium and sodium carbonate contaminated by about 2% copper. Approximately 200 tons of scale were deposited at the landfill.

Aerial photography from 1961 also shows that several uncontained storage/processing tanks and a wastewater disposal pit were located on the site. By 1974, additional contained storage/processing tanks have replaced the uncontained tanks and wastewater disposal pit.

29. A and B Barrel Company, 8604 Dallas Avenue (1955); Reference No. 2

In the reconditioning and repainting of used barrels and drums, the A and B Barrel Company used about one ton per month of sodium hydroxide as a cleaning agent. Liquid waste, including oils, grease and sodium hydroxide, were discharged into a small pond which overflowed directly into the Duwamish. Wastewater concentrations contained 940 mg/l NaOH.

30. (1940) N47 31.1' - W122 17.6'; Reference No. 1

This was the site of a petroleum distributor. All tanks were contained, but aerial photography indicates past spills. This site was removed by the construction of the King County Airport extension by 1961.

31. Ace Galvanizing, 429 South 96th; Reference Nos. 4, 8

Ace Galvanizing discharges into a yard catch basin which flows into a storm water collection ditch. Water samples collected in the ditch contained total metals concentrations up to 0.02 mg/l Cd; 0.92 mg/l Cr; 0.74 mg/l Cu; 6.8 mg/l Ni; 1.7 mg/l Pb; and 250 mg/l Zn. Zinc slag is also stored on-site.

32. Advance Electroplating, 9585 8th Avenue South; Reference Nos. 4,8

Advance discharges rinsewater from chromium, copper, cadmium and nickel electroplation and galvanizing processes into a neutralizing pit which overflows directly into the storm drain. Discharge concentrations of zinc and nickel were measured at 9.30 mg/l Zn and 2.20 mg/l Ni.

33. (1940) N47 31.05' - W122 17.95'; Reference No. 1

This site contained at least 10 uncontained storage tanks in 1940. By 1961, the number of tanks was reduced to four, and by 1980, the tanks were removed and the site paved over.

34. (1961) N47 28.9' - W122 15.4'; Reference No. 1

This small industrial facility had on-site storage/processing tanks which were uncontained. Aerial photography shows that by 1974, an uncontained horizontal storage tank has been added to the site. 1980 photographs show six additional uncontained horizontal tanks.

35. Sunset Demolition, 13300 Empire Way South (1985); Reference No. 3

This landfill has been receiving solid wastes from Todd Shipyard and Jorgensen Steel. The wastes deposited in the landfill include sandblasting waste from Todd, and foundry sand and/or, possibly, fly ash from Jorgensen. The runoff from the site is reported to have high levels of copper, lead and chromium. A runoff sample was collected in December 1984 and analysis of that sample should be completed by January 1985.

DREDGE AND FILL HISTORY

INTRODUCTION

The following sections describe the historical shoreline changes and current dredge and fill practices in the Duwamish River. Most of the major dredge and fill operations occurred in the early 1900's. More recent dredge and fill operations have been generally limited to maintenance dredging of the main channel and terminals, and filling for construction and expansion of terminals.

The U.S. Army Corps of Engineers regulates the dredge and fill operations in the Duwamish River and has kept records of these operations since 1965. Prior to 1965, only limited information, such as historical maps and records, is available.

HISTORICAL SHORELINE AND WETLAND CHANGES

Bortleson, et. al. conducted a detailed investigation of the Duwamish River historical features and reported the following:

"The shoreline and wetland environment of the Duwamish River delta has changed dramatically in the past 125 years. The most notable changes since the earliest surveys are the massive landfill of the intertidal reach of Elliott Bay and the channelization of the Duwamish River.

In 1854, the Duwamish River meandered across its valley and entered Elliott Bay through three main distributary channels. A broad intertidal area extended bayward beyond marshlands near the river mouth to near the northern edge of the present-day Harbor Island. Smaller areas of wetland were located in an embayment southwest of the West Waterway, east of the small peninsula of land that was early Seattle.

In 1895, the filling of the marsh and intertidal area began with the dredging of the East Waterway. Material dredged from the East Waterway was deposited as fill over a wide area of what today is Harbor Island. From 1901 to 1904, several thousand cubic meters of material were removed from Beacon Hill to the intertidal area by hydraulic sluices. By 1917, the East and West Waterways had been formed and more than 5.7 sq km (2.2 sq mi) of intertidal area had been filled, largely by deposition of dredge spoil from the two water ways which flanked it. All the former

marsh except a small area on the northern tip of Kellogg Island has been filled or converted to urban land use. Dredging to form the Duwamish Waterway has created a channel deeper than the former natural channel and has lengthened the landward incursion of saltwater in the channel."

Approximate locations and dates of the major changes to the Duwamish River are shown in Figure 4. The main changes to the river occurred between 1895 and 1921, with the main channel construction completed in 1918.

Filling of the old river channel was conducted in 1918. (See Figure 1 and 2 overlays for the old river configuration.) Although the source of the fill is unknown, it can be assumed that the dredge spoils from main channel construction were used as fill material. Unconsolidated fill deposits can contain conduits for ground water movement and special notice should be given to waste disposal sites located on fill material. (See Figures 1 and 2.) This condition is evidenced by the subsiding of ground on hydraulic fill along the Duwamish River, which occurred during the 1949 and 1965 earthquakes, apparently as a result of liquification during ground shaking (USGS, 1975).

It is interesting to note that "background" alluvial sediments from the Green/Duwamish River presently contain rather high mercury concentrations (average = 7 mg/kg dry wt.), presumably from the erosion of natural mercury veins adjacent to the river in its upper reaches (Harper-Owes, 1983). River-derived fill material may also contain similar levels of this metal, though previous sediment inputs from other river systems which have since been diverted out of the Duwamish (the White and Black Rivers in 1906 and 1916, respectively) may have diluted this concentration considerably.

DREDGE AND FILL PRACTICES

General

The U.S. Army Corps of Engineers, the Port of Seattle and private individuals and companies conduct dredging operations on portions of the Duwamish Waterway.

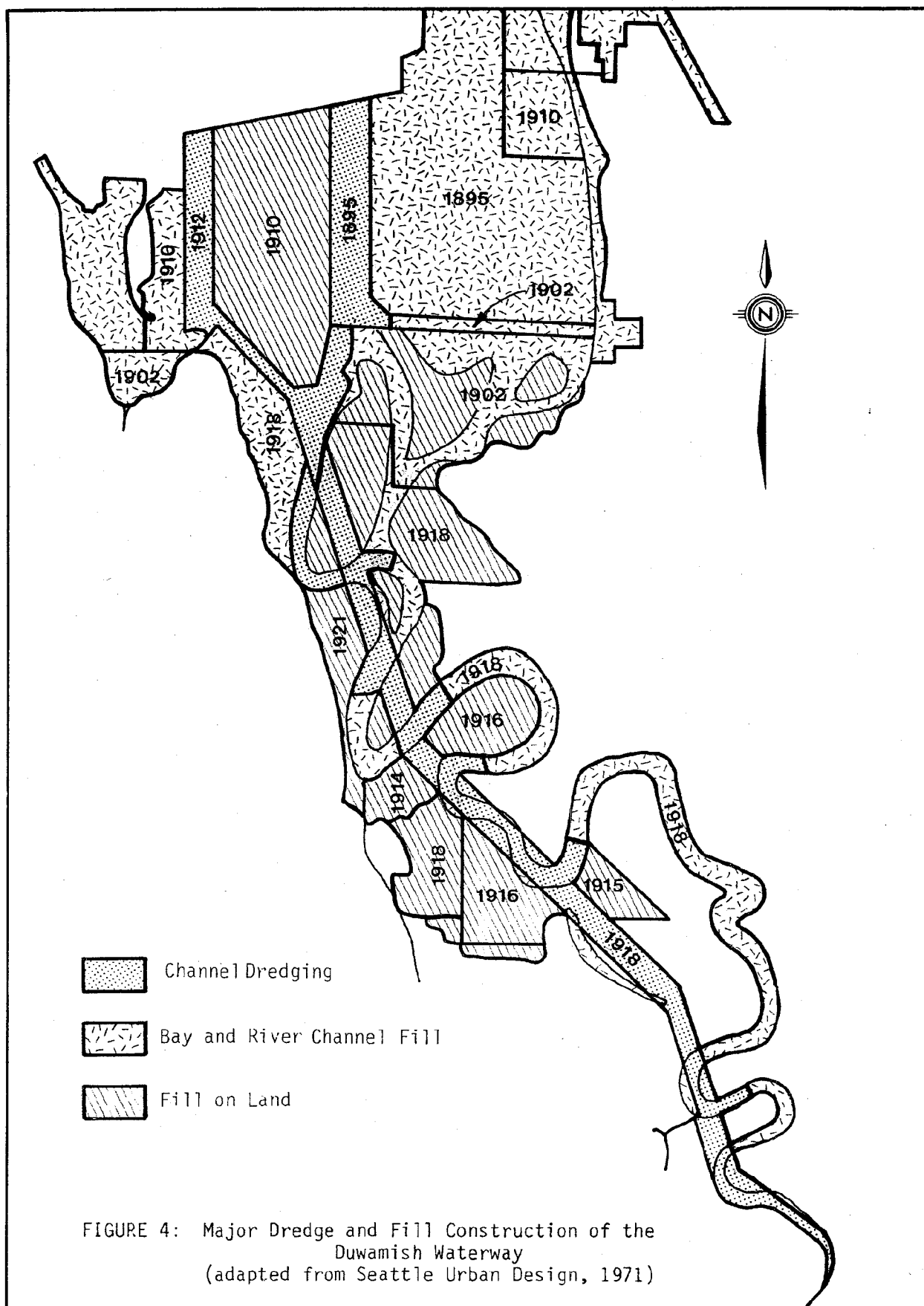


FIGURE 4: Major Dredge and Fill Construction of the Duwamish Waterway
(adapted from Seattle Urban Design, 1971)

Sediments must be periodically dredged for maintenance and construction of navigation channels, berths and terminals for deep-draft shipping in the waterway. Disposal of the dredged materials is regulated by the Corps of Engineers under Section 404 of the Clean Water Act of 1977. The Corps grants permits for the disposal of dredged materials at designated disposal sites subject to approval by the USEPA and the Washington State Department of Ecology. The EPA requires chemical testing of the materials to be dredged and determines if the material can be disposed of at the open-water disposal area in Elliot Bay (Four Mile Rock). Dredge material judged by the EPA to be too contaminated for open-water disposal is either contained and capped in shoreline fills or placed in confined upland disposal areas.

Corp of Engineers

The Corps of Engineers conducts maintenance dredging of the main channel of the Duwamish about every one or two years. A summary of the Corps' maintenance dredging of the waterway is presented in Table 8. All Corps of Engineers maintenance dredge spoils have been disposed of at Four Mile Rock.

Port of Seattle

Port of Seattle dredge and fill records are presented in Table 9. No records have been found which identify the locations of the upland disposal sites. Most upland disposal sites, however, are most likely located near the dredging site in order to minimize transportation costs.

Figures 1 through 3 show terminal disposal areas which have received dredge spoils. Some upland disposal sites have been identified from areal photography; however, the source of the dredge material is unknown.

Fill material quantities deposited at Port of Seattle terminal fill sites are presented in Table 10. Table 11 qualitatively indicates the potential for elevated

**TABLE 8. Summary of Duwamish Waterway Maintenance
Dredging Quantities; 1960-1984**

Maintenance Dredging (m ³ /year)				
Year	COE 0-92 km 1.2-4	COE 92-157 km 4-6	COE 157-223 km 6-8	COE 223-276 km 8-10
1960	-0-	-0-	36,800	188,000
1961	-0-	78,100	-0-	-0-
1962	-0-	-0-	-0-	-0-
1963	-0-	-0-	-0-	-0-
1964	6,600	41,200	192,200	413,700
1965	-0-	-0-	-0-	-0-
1966	-0-	-0-	-0-	-0-
1967	-0-	-0-	-0-	-0-
1968	6,100	74,400	49,700	314,100
1969	-0-	-0-	-0-	-0-
1970	-0-	-0-	-0-	-0-
1971	-0-	-0-	-0-	248,600
1972	-0-	-0-	-0-	-0-
1973	-0-	-0-	-0-	-0-
1974	-0-	-0-	-0-	100,700
1975	-0-	-0-	-0-	219,400
1976	-0-	-0-	44,300	215,600
1977	29,100	37,500	-0-	131,900
1978	-0-	-0-	110,400	22,900
1979	-0-	-0-	-0-	-0-
1980	-0-	-0-	-0-	157,200
1981	-0-	-0-	-0-	92,100
1982	-0-	-0-	-0-	95,600
1983	-0-	-0-	-0-	96,500
1984	840	-0-	-0-	67,300
AVERAGE	1,600	9,200	16,000	88,500

TABLE 9. Port of Seattle Dredge Record for the Duwamish Waterway

Dredge Location	Year	Dredge Quantity (m ³)	Disposal Site
Terminal 5	1969	22,100	Upland site
Terminal 5	1969	425	Terminal 5 site
Terminal 5	1971	12,700	Upland site
Terminal 18	1966	100,000	Terminal 18 fill
Terminal 18	1967	62,000	Terminal 18 fill
Terminal 18	1971	14,400	Upland site
Terminal 19	1974	85,500	Pamco Duwamish Boulevard disposal sites
Terminal 20	1971	14,400	Upland site
Terminal 20	1973	72,200	Kellogg Island
Terminal 20	1978	4,380	Terminal 42 fill site
Terminal 25	1971	8,920	Upland site
Terminal 25	1971	67,900	Not known
Terminal 25	1972	13,200	Not known
Terminal 25	1973	1,890	Four Mile Rock
Terminal 25	1978	15,900	Terminal 42 fill site
Terminal 30	1971	34,000	Upland site
Terminal 30	1978	15,900	Terminal 30 fill site
Terminal 46	1979	162,000	Terminal 30 fill
Terminal 105	1967	110,000	Upland site
Terminal 105	1967	5,090	Terminal 105 fill
Terminal 105	1978	9,770	Terminal 42 fill site
Terminal 115	1969	754,800	Terminal 115 fill
Terminal 115	1978	41,900	Terminal 42 fill site
Terminal 115	1979	16,600	Four Mile Rock
Terminal 128	1974	101,000	Four Mile Rock
Terminal 128	1974	59,600	Terminal 115 fill
Terminal 128	1974	13,800	Terminal 128 fill
Terminal 128	1975	74,200	P-2 fill

concentrations of heavy metals, PCB and PAH in the dredge spoils used as fill for each terminal site. The reported concentrations are based on the annual deposition-weighted values for the main channel reach adjacent to the dredged terminal (Harper-Owes, 1983). It should be noted that the actual concentrations of the terminal dredge spoils are not known. The main channel concentrations are presented only to indicate the possible order of magnitude of levels present in the dredge spoils.

Private Individuals and Companies

Several landowners along the Duwamish Waterway periodically engage in dredge and fill practices. A summary of the Corps of Engineers permits which regulate the dredge and fill activity is presented in Table 12. Most of the dredge material has been disposed of at Four Mile Rock. Again, when uplands disposal is indicated, the disposal site is unknown.

PCB Spill and Clean-up

On September 13, 1974, an electric transformer destined for arctic service was dropped and broken on the north pier of Slip 1 of the Duwamish River. As a result, PCB transformer fluid, Aroclor 1242, was discharged onto the pier and into the water. After becoming aware of the type and quantity of fluid spilled, EPA acted to determine the extent of pollution. Once determined feasible, clean-up of the fluid was attempted using several hand dredges.

Results from EPA Region X Laboratory's monitoring of this initial clean-up operation indicated only eighty of an estimated 255 gallons of PCB were recovered and the remaining fluid had begun to spread throughout the slip and into the river channel (Blazevich, et. al., 1977). Recognizing the seriousness of this problem, EPA and the Army Corps of Engineers conducted a second recovery operation to remove the remaining PCB using a hydraulic dredge.

TABLE 10. Port of Seattle Terminals Fill Quantities

Terminal	Quantity of Fill (m ³)	Source of Fill Material
Terminal 5	425	On-site dredging
Terminal 18	162,000	On-site dredging
Terminal 18	346	On-site material and/or dredging
Terminal 25	Not known	Not known
Terminal 30	15,900	On-site dredging
Terminal 30	162,000	Terminal 46 dredging
Terminal 30	13,000	On-site material and/or dredging
Terminal 42	4,380	Terminal 20 dredging
Terminal 42	15,900	Terminal 15 dredging
Terminal 42	9,770	Terminal 105 dredging
Terminal 42	41,900	Terminal 115 dredging
Terminal 102	Not known	Not known
Terminal 105	5,090	On-site dredging
Terminal 105*	12,000	Terminal 18/20 dredging
Terminal 106	Not known	Terminal 102 (?)
Terminal 107	54,000	Terminal 20
Terminal 107	4,000	Not known
Terminal 115	754,800	On-site dredging
Terminal 115	59,600	Terminal 128 dredging
Terminal 128	13,800	On-site dredging
Terminal 128	23,000	On-site material and/or dredging

*This disposal site is currently being investigated by the Port of Seattle to determine if the dredge spoils have resulted in significant contamination of local ground water (J. Dohrman, Port of Seattle, personal communication).

**TABLE 11. Typical Chemical Quality of Main Channel Sediments
Adjacent to Construction Dredge Sites (mg/kg dry wt.)**

Dredge Location	Arsenic ^a	Cadmium ^a	Copper ^a	Mercury ^a	Lead ^a	Zinc ^a	PCB ^b	PAH ^c
Terminal 5	50	3	270	L/1	510	510	0.5	9
Terminal 18	40	3	100	L/1	150	200	1.5	6
Terminal 19	40	3	100	L/1	150	200	1.5	6
Terminal 20	40	3	100	L/1	150	200	1.5	6
Terminal 25	40	3	100	L/1	150	200	1.5	6
Terminal 30	40	3	100	L/1	150	200	1.5	6
Terminal 46	--	--	--	--	--	--	--	--
Terminal 105	30	4	80	L/1	130	310	2.5	5
Terminal 115	20	2	40	L/1	40	110	1.3	2
Terminal 128	7	2	30	7	40	100	1.3	2

^a1972-1982

^b1973-1977

^c1978-1982 (PAH denotes polynuclear aromatic hydrocarbons)

**TABLE 12. Private Dredge and Fill Operations
Along the Duwamish Waterway**

Date	Name	Work Description	Dredge Spoils Disposal
1965	Washington State Highways	Dredge	1
1965	SS Mullen, Inc. (slip 3)	Dredge and disposal, fill	1
1965	Ideal Cement	Fill	-
1966	SS Mullen, Inc.	Dredge and fill	1
1966	RC Crow	Fill	-
1967	Duwamish Shipyard	Dredge	1
1968	Monsanto	Dredge	1
1969	Boeing	Fill	-
1969	Manson Construction	Dredge and disposal	1
1969	Kaiser Cement	Dredge	1
1970	Glacier Sand and Gravel	Fill (construction rubble)	-
1970	City of Seattle	Dredge	1
1970	S. Idaho Street		
1970	Monsanto	Dredge	1
1972	Northwestern Glass	Fill	-
1973	Monsanto	Dredge	1
1973	Boeing	Fill	-
1973	Boyer Towing	Dredge	1
1973	Pacific Construction	Dredge	1
1973	Hurlen Construction	Dredge	1
1973	Seaboard Lumber	Dredge	1
1974	Boulevard Excavating	Dredge and fill	1
1975	Monsanto	Dredge and disposal	1
1976	Boyer Alaska Bargelines	Dredge	1
1976	Bruce Hansen	Dredge	1
1976	Delta Marine	Dredge	1
1977	Hale and Gilmur	Dredge	1
1977	Chiyoda International	Fill	-
1977	Manson Construction	Fill	-

Table 12 (continued)

Date	Name	Work Description	Dredge Spoils Disposal
1977	AWI Sand and Gravel	Fill	-
1977	Duwamish Marina	Dredge and disposal	1
1977	Taylor, E.L.	Fill	-
1978	Pott, Tom	Fill	-
1978	Naifonov, S.A.	Fill	-
1978	Seaboard Lumber	Dredge	1
1978	Hale's Construction	Fill	-
1978	Utilities Warehouse	Fill	-
1978	Manson Construction	Dredge and fill	1
1978	Slater, Robert W.	Fill	-
1978	Ideal Cement	Maintenance dredging	Four Mile Rock
1979	Kaiser Cement	Dredge	Four Mile Rock
1979	Marine Power & Equipment	Dredge and fill	1
1980	Hurlen Construction	Dredge	Four Mile Rock
1980	Lone Starr	Dredge	mtl used in cement kilns
1981	Marine Power & Equipment	Dredge (65,000 m ³) (3 years)	Four Mile Rock
1981	Delta Marine	Dredge	Four Mile Rock
1981	Foss Alaska Line	Dredge	Four Mile Rock
1981	General Construction	Dredge	Four Mile Rock
1981	Lynden Transport	Dredge and Fill	Fill behind bulk- head & Four Mile Rock
1981	Duwamish Shipyard	Dredge (9,200 m ³)	Four Mile Rock
1981	Duwamish Shipyard	Maintenance dredging (5 years)	Four Mile Rock
1981	Marine Power & Equipment	Fill	-
1982	Hale and Gilmer 6343 First Ave. S.	Dredge (4,600 m ³)	Upland Disposal
1982	Duwamish Yacht Club	Dredge (460 m ³)	Upland Disposal
1982	Duwamish Yacht Club	Maintenance dredging	Four Mile Rock
1982	Morton Marine Equipment	Maintenance dredging (5 years)	Four Mile Rock

Table 12 (continued)

Date	Name	Work Description	Dredge Spoils Disposal
1982	General Construction	Maintenance dredging (6 years)	Four Mile Rock
1982	Western Marine Construction	Dredge	Four Mile Rock
1982	Hale and Gilmur	Fill	-
1983	Lynden Transport	Maintenance dredging (10 years)	Four Mile Rock
1983	Muckleshoot Indian tribe	Fill	-
1983	Manson Construction	Dredge (5,400 m ³)	Four Mile Rock
1983	Manson Construction	Maintenance dredging (600 m ³ /year-10 years)	Four Mile Rock
1984	Kaiser Cement	Maintenance dredging (10 years)	Four Mile Rock
1984	Boeing Military	Fill	-
1984	Steinman, Merle 7410 5th Ave. S.	Dredge (140 m ³)	Upland Disposal

1. Information currently not available; may be available in Corps of Engineers Archives.

The Corps of Engineers piped the contaminated sediments to a disposal site prepared on land 2,000 feet north of the slip and immediately adjacent to the river (Figure 1). All dredge spoil water from the hydraulic dredge was treated with flocculent, passed through three unlined disposal ponds and filtered through both a particle filter and an activated carbon treatment unit. Effluent water from the treatment system contained acceptably low PCB levels (<0.3 ug/l) to warrant return discharge to the Duwamish (Blazevich, et. al., 1977). Most of the PCB "treatment", however, resulted from particulate deposition within the disposal ponds, which accumulated an estimated $5,470 \text{ m}^3$ of sediments. The PCB concentration of these dredge spoils varied from 31 to 185 mg/kg wet weight, with the higher concentration generally occurring at sites closest to the river. The volume-weighted average concentration was estimated at 116 mg/kg as wet weight, or roughly 180 mg/kg as dry weight.

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